CHEMICAL CONTROL OF SOIL INSECTS AND RELATED ORGANISMS ATTACKING SUGARCANE

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We may divide the soil-inhabiting insects and related small animals that injure sugarcane into two classes. The first class includes the smaller insects and animals that cut off or gnaw small holes in sugarcane roots and prune off the root hairs. The second class is made up of only those insects that may cause heavy injury to the roots, as the sugarcane beetle, Euetheola rugiceps (Lec.), sugarcane weevil, Anacentrinus subnudus Buch., and wireworms.

The insects in the first class directly damage the root system and check plant growth. Their gnawing also causes wounds that form entrance places for the Pythium fungi, the causal agents of root rot. These insects, which are listed in table 1, are found in Louisiana sugarcane fields at the average rate of 8,800,000 per acre. Injury by these insects is more important in heavy soils, where root rot is more prevalent.

Table 1.--Average numbers of soil insects and other small soil animals found in a square foot of soil to a depth of 8 inches in sugarcane fields.

Soil animal	Louisiana	Florida	Georgia
Symphilid (Hanseniella unguiculata (Hansen))	80	143	94
Springtail (Lepidocyrtus violentus)1/	22	31	23
(Lepidocyrtus cyaneus Tullberg)	3	Rare	0
(Onychiurus armatus Tullberg)	35	80	66
Japygid (Japyx sp.)	30	0	3
Snail (Zonidoides arboreus (Say)	19	Rare	0
Centipede (Arenophilus bipuncticeps (Wood))	3	7	4
Injurious millipeds	10	Rare	0
Total	202	261	190

1/ Equals Pseudosinella violenta (Folsom)

In control studies in the vicinity of Houma, La., land drained from 3 to 6 feet had about 40 percent fewer injurious soil insects than the land having the usual drainage. Summer planting of sugarcane, which allows the cane to develop a good root system prior to the growing season, lessens the importance of injury by the small soil insects.

A number of years ago, in cooperation with R. D. Rands,1/ we investigated the use of chemicals, available at that time, in the control of the soil insect-root rot complex. Although some reduction in soil insects was obtained with some of them, the chemical either injured the cane or did not give a sufficient reduction to be economical.

In an experimental field planted in November 1945, various formulations of DDT were tested in soil-insect control. In March of the next year there was a 13-percent reduction in the number of injurious soil insects in plots treated with 400 pounds

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of a 1-percent DDT dust per acre. In May there were 49 percent more plants in plots receiving that treatment, and at harvesttime there were 26 percent more stalks of millable cane than in untreated plots. In this and all other small-scale experiments with soil insecticides the material was applied by hand on the stalks of cane in the planting furrow, and the cane was then covered with soil in the usual manner. In later large-acreage experiments, a fertilizer distributor proved a satisfactory means of applying the soil insecticide on the cane in the planting furrow.

In October 1947 experiments were begun on two fields in Louisiana with various chemicals for soil-insect control. One field was on heavy soil on the Aragon Plantation at Montegut, and the other on medium soil on the Woodlawn Plantation at Houma. In each field there were 25 plots 3 rows wide and 48 feet long. The results are given in table 2. A comparison of results in the treated and untreated plots on heavy soil shows that 1-percent chlordane gave a 60-percent decrease in injurious soil insects in February, a 39-percent better stand of cane in May, and an increased yield of 5.3 tons of cane and 1,021 pounds of sugar per acre. One-percent toxaphene gave an insect decrease of 79 percent, a stand increase of 41 percent, and yield increases of 2.8 tons of cane and 509 pounds of sugar per acre. Benzene hexachloride gave the second greatest increase in yield, followed by DDT.

On medium soil 1-percent toxaphene and 1-percent chlordane gave the best results. Both materials gave a 66-percent decrease in injurious soil insects in March and toxaphene gave a 13-percent and chlordane a 30-percent increase in plants per plot in May over that in the untreated check. Yield data were not obtained.

At the same time that the experiments on soil insecticides were begun, two experiments on the use of soil fumigants were started in cooperation with the South Coast Corporation. The chemicals were in liquid form and were applied with a soil applicator at 1-foot intervals and 6 inches deep on 0.1-acre plots. D-D(dichloropropane-dichloropropylene) and ethylene dibromide were tested on heavy soil and D-D on light soil. The results are given in table 3. Plots treated with D-D at the rate of 20 gallons per acre had 82 percent fewer injurious insects than the untreated plots in October 1947, 66 percent fewer in November, 32 percent in March 1948, a 19-percent better stand of cane in May, and a yield increase of 5.4 tons of cane and 813 pounds of sugar per acre. In the same experiment 40-percent ethylene dibromide applied at the rate of 15 gallons per acre did not give so good control of soil insects or so great an increase in stand of cane as D-D, and the yield was only 2.2 tons of cane and 149 pounds of sugar more per acre than in the untreated plots. In an experiment on light soil D-D gave decreases in the soil insect population of 73 percent in October 1947 and 31 percent in March 1948, a stand increase of 19 percent in May, and an increased yield of 2.0 tons of cane and 477 pounds of sugar per acre. D-D has been found very valuable in controlling nematodes in Hawaiian pineapple fields and soil insects in California truck-crop fields and elsewhere. Cane was planted on the test plots, in variety C. P. 36/105, on October 1, 1947.

It appears possible that stands of cane and yields may be increased by the use of D-D or one of the other soil insecticides on sugarcane before or at planting time, especially in heavy soils. The cost per acre of applying soil insecticides is estimated at $13 for toxaphene and benzene hexachloride, $15 for DDT, $21 for chlordane, and $40 for D-D. However, in the fall of 1948 the Shell Oil Company made large-scale experiments in which they applied D-D by means of three tubes 12 inches apart on top of the row and thus greatly reduced the cost of application. It remains to be seen whether fumigation on the top of the row is as effective as fumigating both the tops of the rows and the furrows between the rows.

In 1947 toxaphene, benzene hexachloride, and DDT were tested in the Lafayette, La., area as controls of the sugarcane weevil, but the weevil infestation was so light that results were inconclusive.

Table 2.--Results of two experiments with planted seed cane treated with different insecticides for control of soil insects. Sugarcane planted in October 1947, harvested in December 1948.

Insecticide	Dosage of active ingredient per acre	Experiment on heavy soil					Experiment on medium soil	
		Soil insects per plot Feb. 16-19	Plants per plot May 17-18	Yield			Soil insects per plot Mar. 15-18	Plants per plot May 19
				Cane per acre	Sugar per acre	Sucrose		
	Pounds	Number	Number	Tons	Pounds	Percent	Number	Number
Chlordane, 1%	4	45	1306	39.6	7,488	13.98	43	499
BHC (0.2% gamma)	0.8	56	1194	38.1	7,345	14.24	42	363
DDT, 1%	4	77	1187	37.5	7,120	14.04	162	459
Toxaphene, 1%	4	24	1327	37.1	6,976	13.96	43	432
Check, no treatment		112	941	34.3	6,467	13.91	128	384
Difference required for significance:								
at 5% level		31	177	2.0	458		27	76
at 1% level		44	248	2.8	642		38	106

Table 3.--Results of two experiments on Lower Terrebonne Division of the South Coast Corporation, Montegut, Louisiana, with soil fumigants applied to 0.1-acre plots about 2 weeks before planting. Cane planted October 1, 1947 with C. P. 36/105, harvested December 13 and 14, 1948.

Insecticide	Dosage per acre	Injurious soil insects per plot: Oct. 9 and 20, 1947	Nov. 4, 1947	Mar. 23 and 29, 1948	Plants per plot May 17 and 18, 1948	Yield per acre: Sucrose	Cane	Sugar
	Gallons					Percent	Tons	Pounds
Aragon Plantation, heavy soil								
D-D	20	11	21	213	4,060	14.70	37.5	7,570
Ethylene dibromide, 40%	15	34	44	270	3,780	14.74	34.3	6,906
Check, no treatment		61	62	315	3,420	15.20	32.1	6,757
Differences required for significance:								
at 5 percent level					400	0.50	4.6	1,116
at 1 percent level					600	0.76	7.0	1,699
Pointe Farms, light soil								
D-D	20	29		172	2,522	17.07	25.4	6,298
Check, no treatment		108		249	2,128	17.09	23.4	5,821

Rather satisfactory wireworm control has been obtained by summer planting, but it is often impossible to plant any or all cane at that time of the year. Consequently, an experiment was made in October 1947 in which four soil insecticides were tested as wireworm controls on plots 3 rows wide and 48 feet long. The results are given in table 4. Chlordane gave a 4½-fold increase in stand over that in the untreated check area, toxaphene a 4-fold increase, benzene hexachloride a 3½-fold increase, and DDT doubled the stand. Examination of samples of planted cane showed wireworm injury correspondingly reduced. When compared with the check, the yields in the treated plots were increased 18.1 tons and 3,369 pounds with chlordane, 15.8 tons and 3,063 pounds with toxaphene, and 16.7 tons of cane and 2,729 pounds of sugar with benzene hexachloride.

Table 4.--Results of 25-plot experiment on Church Plantation, Edgard, La., with planted seed cane treated with various insecticides to control wireworms. Cane planted October 10, 1947 with variety C. P. 36/105. Harvested November 9, 1948.

Insecticide	Dosage of active ingredient per acre	Plants per acre May 14, 1948	Yield per acre	
			Cane	Sugar
	Pounds	Number	Tons	Pounds
Chlordane, 1%	4	49,000	46.8	8,015
Toxaphene, 1%	4	45,500	44.5	7,709
BHC, 0.2% gamma	0.8	41,300	45.4	7,375
DDT, 1%	4	26,300	39.5	6,714
Check, no treatment		11,500	28.7	4,646
Differences required for significance:				
at 5 percent level		12,200	8.5	1,399
at 1 percent level		17,000	11.9	1,962

In 1948 an experiment was made to determine the effect of heavy applications of these soil insecticides on borer injury and on the sugarcane plant itself. Heavy applications of benzene hexachloride, DDT, toxaphene, parathion, or chlordane appeared to have no depressing effect on the weight or sucrose content of cane stalks at harvesttime and no residues of the insecticides were found in the juice. Over 120 tons of a dust containing benzene hexachloride in the proportion of 1.3 percent of the gamma isomer have been used at the rate of 100 pounds per acre in Australia to control grubs attacking sugarcane roots with no reported injury to the sugarcane plant. In fact, in experiments as much as 1,000 pounds per acre of the 1.3 percent gamma showed no toxic effect on the sugarcane plant.

There was no evidence that any of the insecticides were upsetting the natural balance of soil fauna. Earthworms were scarce in both treated and untreated samples. No information was obtained in any of the experiments on the possible effect of any of the insecticides tested on the flavor of the sugarcane juice or refined sugar from the treated plots. No such effect seems likely, however, except possibly in the case of benzene hexachloride.

In furtherance of our investigations of soil insecticides, at planting time in 1948 we began four small-plot and three large-plot experiments on chemical control of wireworms and seven small-plot experiments on chemical control of the smaller soil insects associated with root rot.